FALL 2020

THE LEAFLET
VOLUME 2, ISSUE 3

NORTHERN HARDWOODS RESEARCH INSTITUTE'S QUARTERLY NEWSLETTER

THE LEAFLET

HARVEST KNOWLEDGE, PROMOTE GROWTH

THE LEAFLET
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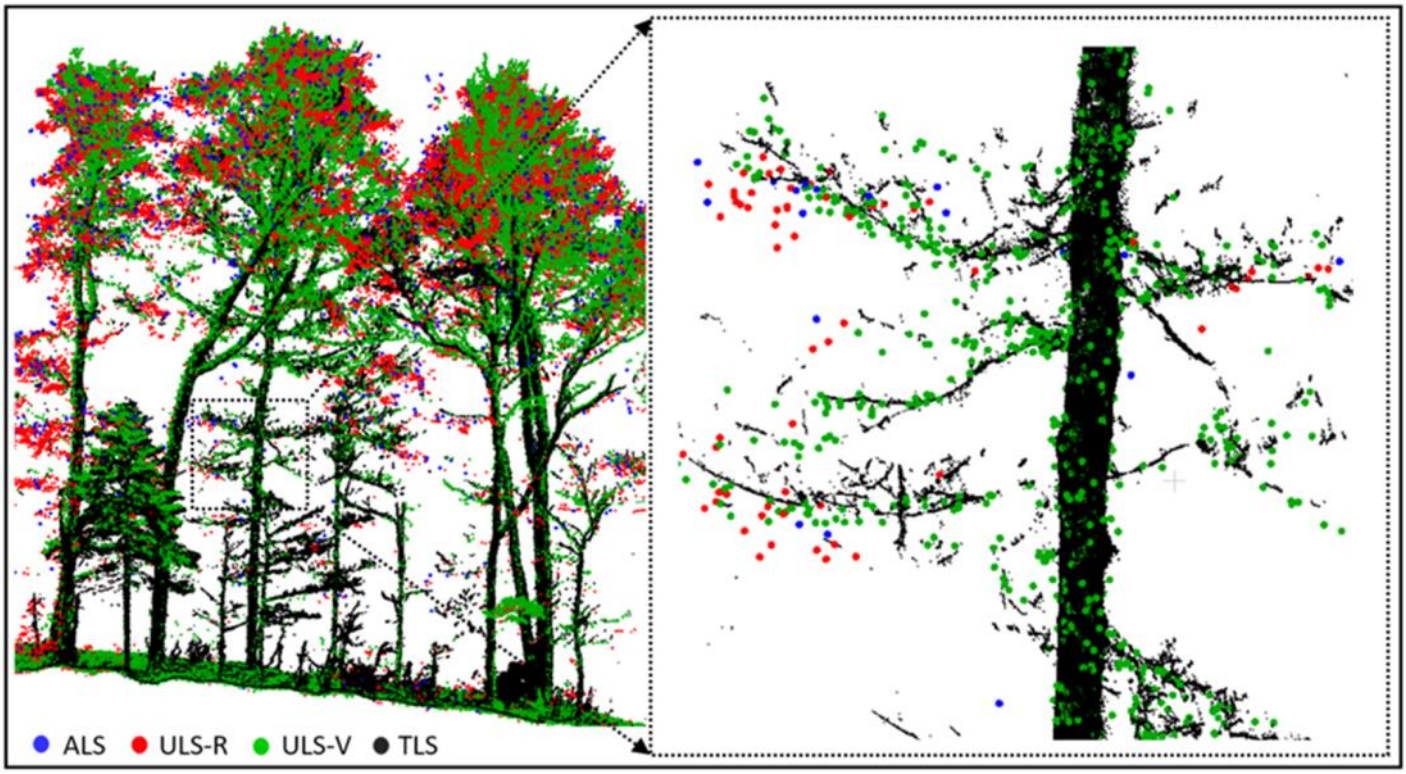
Cover page: Aerial image showing a track harvester conducting a uniform irregular shelterwood treatment in a mixed hardwood stand

FEATURE ARTICLE
Digital TImberlands 2020

The 'Digital Timberlands 2020' project has started!

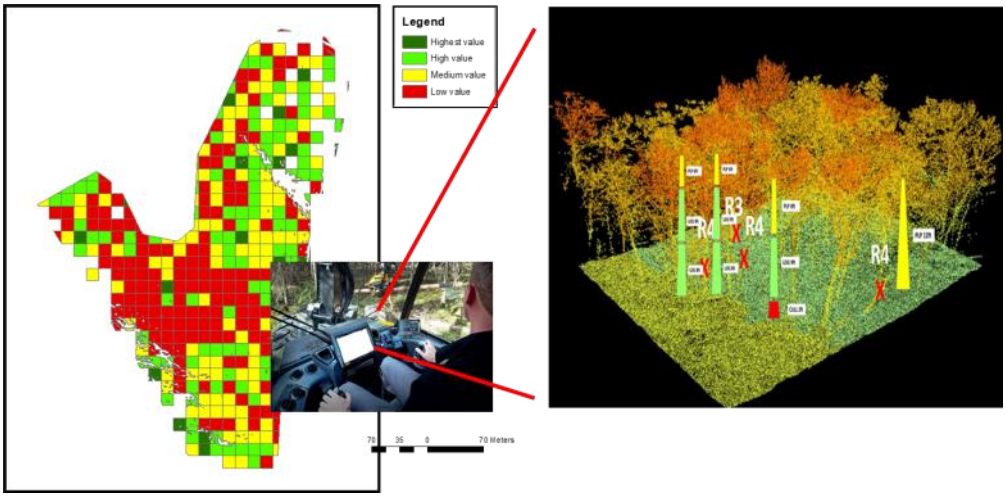
The Northern Hardwoods Research Institute (NHRI) has secured funding for a multi-year project that aims at establishing the basis and to introduce a framework for stakeholders in the New Brunswick forest products sector to engage into the digital transformation of the value chain. It will focus on the upstream part of the value chain (timberlands). Despite substantial advancements in individual components of the value chain such as EFI and on-board-computer data, there currently exists many serious gaps in accuracy of predictions, data integrity, seamless process flow and maturity of the solutions available to users. This project will leverage the benefits of AI and cutting-edge technologies to enable the digital transformation in the forest products value chain and provide the foundation for other processes (out of scope for this NHRI project) downstream.



FEATURE ARTICLE
Digital TImberlands 2020

The general objectives of the project are to:

1. Create a consortium of stakeholders that includes private forest products firms, forest management organizations, related IT firms, equipment manufacturers/distributors, researchers, governments and academia that will focus on digitalization of the forest products value chain,
2. Create a knowledge Hub in New Brunswick that will link and network with others around the globe,
3. Foster a productive ecosystem that will stimulate innovation in the sector,
4. Initiate several pilot projects to explore digitalization options.
5. Introduce artificial intelligence, machine learning and deep learning as standard tools for digitalization of the value chain

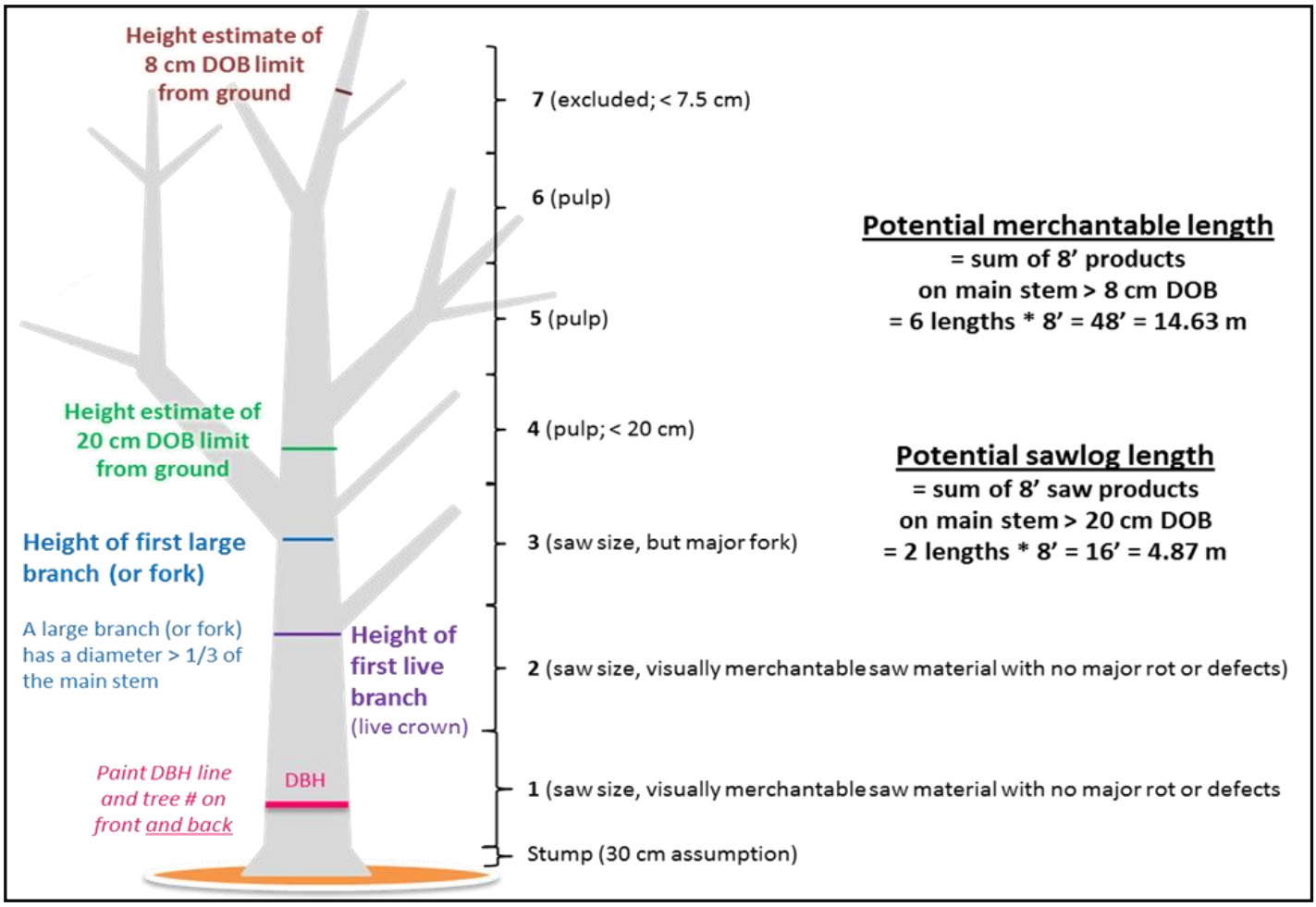


The technical and specific objectives of the project are to:

6. Establish an extensive array of study sites with high intensity information where field trials will be conducted
7. Improve current practices used to generate harvester on-board computer (OBC) data,
8. Improve OBC processes and algorithms to measure and buck trees optimally,
9. Develop processes to integrate this data into the value chain in a 360-degree fashion,
10. Develop methods to correct errors and biases in single-tree and stand inventory data (EFI and OBC),
11 Explore new technologies such as super-dense laser scanning as means to develop next-generation EFI's and to offer visualization tools for machine operators.
12. Improve the simulation of harvesting operations so that characteristics of the trees, harvested are more precise,
13. Improve methods used to geo-tag assortments of products produced by harvesters.

FEATURE ARTICLE
Digital TImberlands 2020

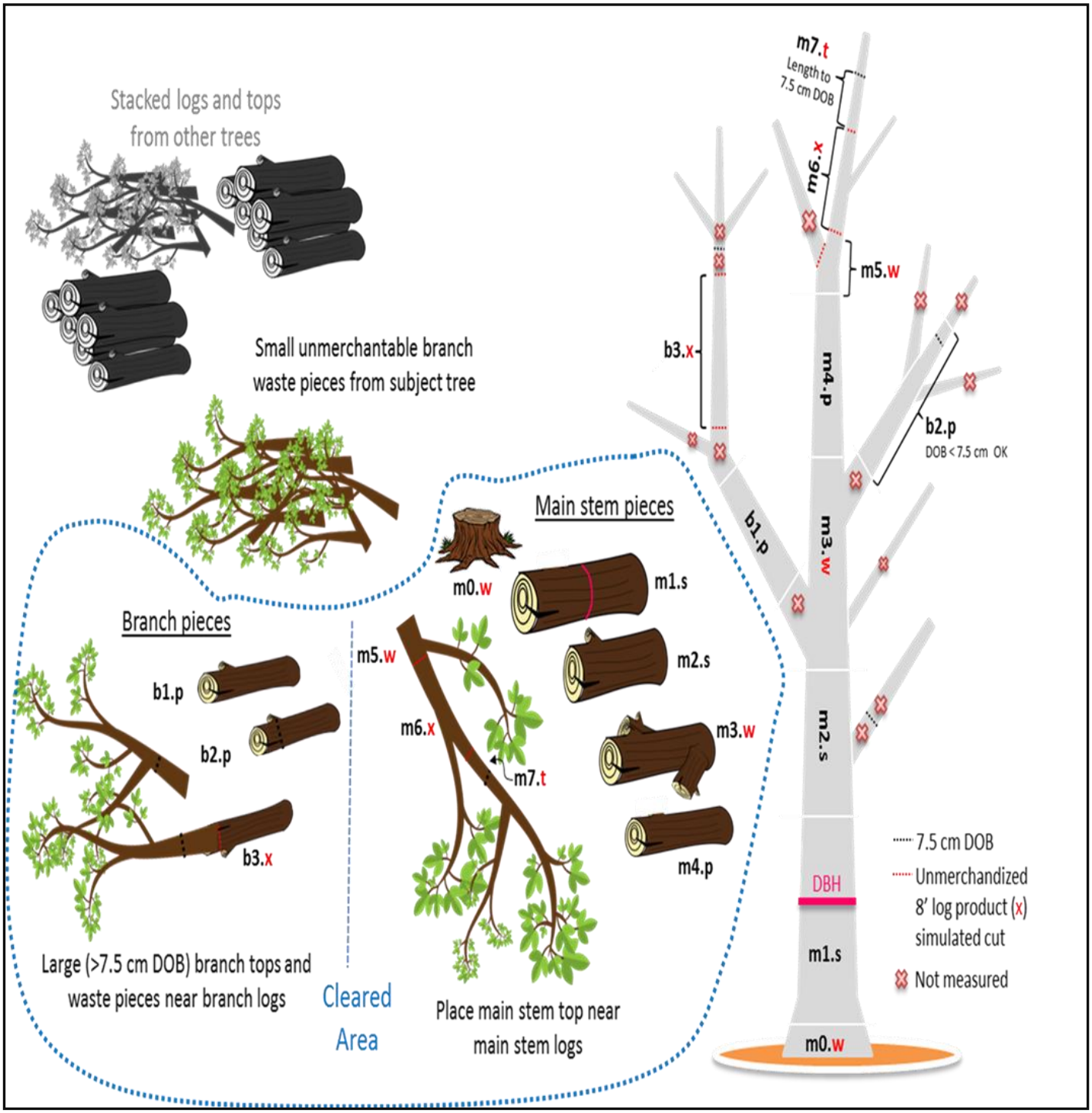
The work has already started and this fall, Pamela and her team have installed 20 one-hectare frames in harvest block in northwestern New Brunswick. These frames have been intensively sampled so that the stand characteristics are well understood before harvest. Nine variable-sample plots are installed in each one-hectare square and detailed measurements are taken on 27 sample trees that are marked and will be tracked after processing by a harvester.



Schematic of measurements taken on the sample trees (Hennigar, 2018)

The bolts produced by the harvester form those sample trees will be further measured to allow an analysis of bucking into products and to determine opportunities to improve and optimize recovery. This is the segment that Caroline Bennemann, a doctoral student at Université Laval (under the direction of Eric Labelle) will undertake with NHRI.

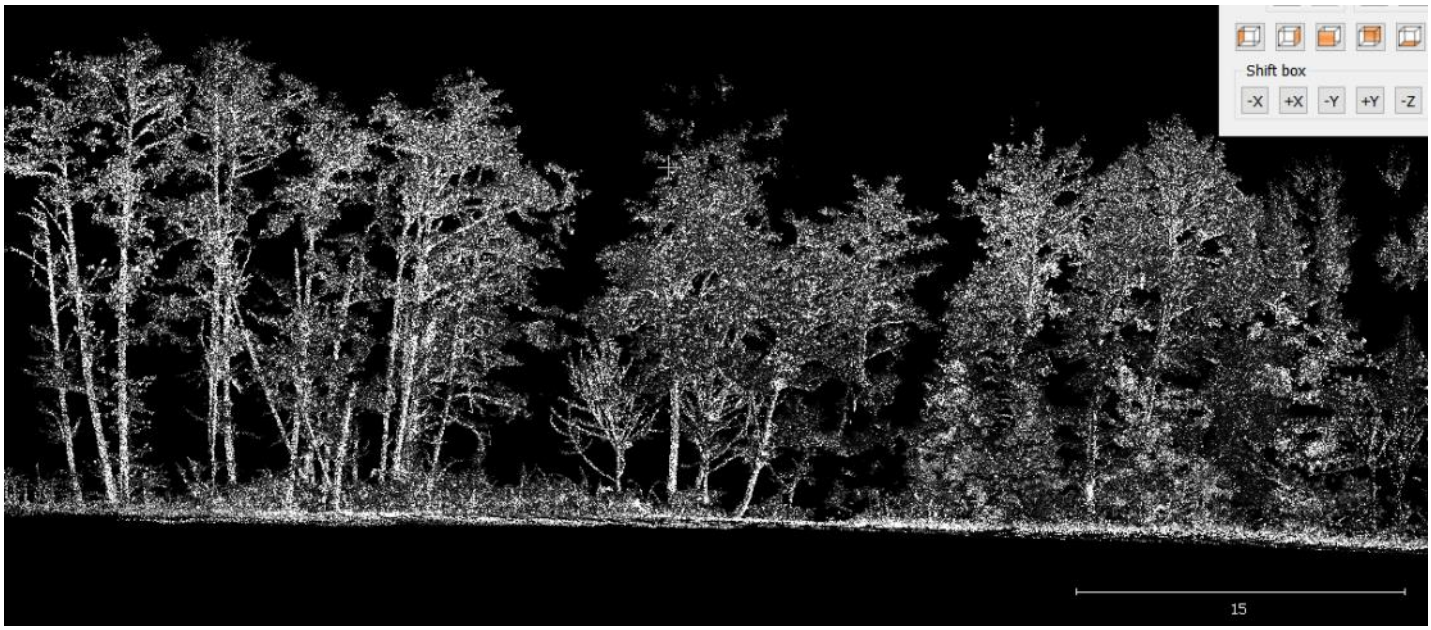
FEATURE ARTICLE
Digital TImberlands 2020



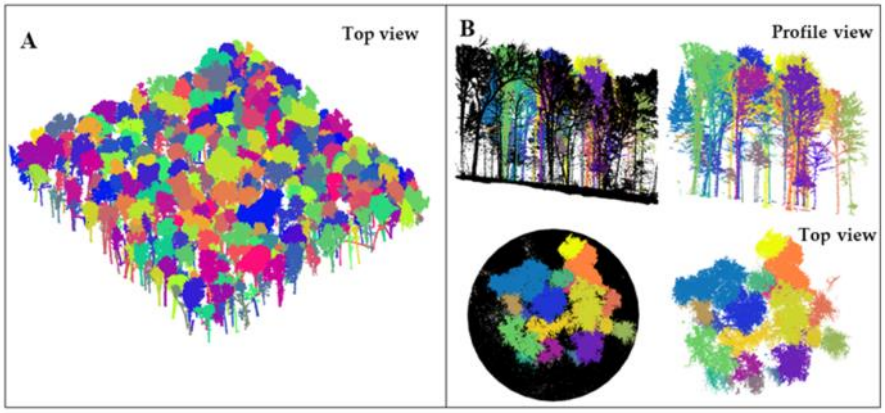
Bolts produced by the harvester will be measured and trees reconstructed to determine best bucking and utilization scenarios (Hennigar, 2018)

FEATURE ARTICLE
Digital TImberlands 2020

The work this fall also involves the acquisition of super-high-density LiDAR point clouds. As a proof of concept, scans will be acquired using mobile LiDAR technology. We are currently experimenting with a backpack unit that consists of two scanners; one positioned horizontally and another one at vertical. This segment is undertaken with the participation of Bastien Vandendaele who is completing his PhD under the direction of Richard Fournier at Université de Sherbrooke. Bastien will be full time on the project and will be developing methods to leverage the technology to extract tree metrics from dense point clouds. We will also be testing drone-based LiDAR technology. The NHRI has been experimenting with UAV LiDAR and terrestrial LiDAR since 2013.



Example of raw data from a mobile LiDAR scan. It is anticipated that error in object size will be less than 5 cm anywhere on a tree. After error and bias corrections, a development activity in this project, accurate predictions of products and volume can be made for every single tree in the experimental frames before harvest.



NEW TECHNICAL NOTES

A Series of Technical Notes from our Phase II is released

A series of Technical Notes from our Phase II has just been released to showcase important work done by the NHRI staff and its collaborators.

Various topics are covered in the subjects of resource characterization, silvicultural treatments and their effects, problematic stands containing Beech, quality, modelization, tools, and much more.

Each Technical Note is designed to deliver tangible benefits to the forest sector by focusing on a problem-solving approach. The goal of these Technical Notes is to provide user-ready knowledge that improves the financial and silvicultural sustainability of hardwood stands. These Technical Notes can provide knowledge and tools to be implemented into our partners and clients' management activities.

Click here to see all of our 23 Technical Notes

DOCUMENTARY VIDEO

Sustainable management of our hardwood forests

The challenge of sustaining the working hardwood and mixed wood forests of Eastern North America

In eastern North America, the Acadian Forest region is prominent and encompasses all of the Canadian Maritime provinces, areas of southern Quebec, as well as the northern New England states. This forest region is closely related to the Great Lakes - St. Lawrence forest to the west and the Boreal Forest to the north. The hardwood-dominated portion of the Acadian forest is of particular importance. Besides providing critical ecosystem services such fixing carbon from the atmosphere and regulating water, it is also a great provider of traditional and non-traditional forest products.

Much of these hardwood-dominated stands are considered part of the working forests. Whether on public or private lands, they are the subject of silvicultural treatments and harvesting to extract goods and products for human consumption. For the production of timber, hardwood stands must be composed of the right species, possess the right quality attributes as well as being healthy and vigorous.

When conducted properly, the practice of silviculture is highly sustainable and in addition, even promotes extra benefits such as the sequestration of carbon from the atmosphere. The creation of new cohorts of trees of desired species and quality is essential to assure that the cycle gets completed. But in order to do so, silviculturists need a solid framework imbedded in the concepts of adaptive management. This is especially true in the context of a changing climate. Retrospective examination of treated stands reveals that unless explicit measures are taken to create the right conditions to regenerate the next cohort of trees, the likelihood of sustaining quality hardwood stands in the future is low.

The first factor to consider is the ability of a site to provide the conditions to regenerate certain tree species. The propensity to regenerate, is dependent on macro and meso climate as well as other biophysical factors. At the finer scale, we look at soil moisture regimes, depth to water table, substrate fertility and how those features might lead to limiting conditions such as prolonged periods of water stress and, high exposure to sun and wind. Finally, soil properties such as pH, cation exchange capacity, organic content and available nutrients can have an effect on what regeneration and plant communities get establish. But there are other factors as well.

DOCUMENTARY VIDEO

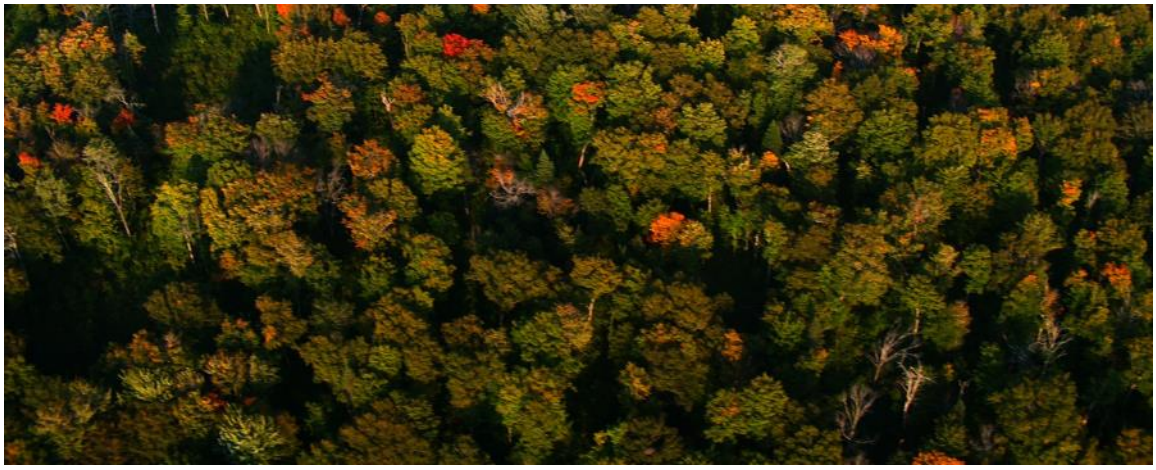
Sustainable management of our hardwood forests

Propensity to regenerate is complex and is addressed as an exercise of determining the potential of hardwood and mixed wood stands to strive. Evidently, it is subject to changes in our climate and viewed as dynamic through time and space. Today, it is fair to say that some of the sustainability issues with regards to hardwood stands are associated with the site's ability to accommodate regeneration of the species of interest.

The creation of the right conditions for seeds to germinate or for trees to propagate vegetatively is an area where a silviculturist can have the most influence. By selecting an appropriate silviculture system and its treatments, a forestry professional can increase the likelihood of regenerating the species of choice on a site by manipulating light as well as the availability of resources and protection. In appropriate stand types where the occurrence of quality trees is low, treatments leaving a low residual basal area can favor shade intolerant and intermediate species. The sudden exposure will also discourage the most shade tolerant species such as American beech.

But simply choosing an appropriate treatment does not guarantee regeneration success. This situation can also be created when treatments are poorly executed, a silviculture regime that was not suitable was selected or operational constraints such as machine type and season were not mitigated. Recent studies have revealed that many previously treated stands have failed to regenerate an acceptable cohort for the future. Many sites are inadequately stocked to desired species, regeneration is unhealthy or of poor quality.

In most cases, the root cause was identified as failure to implement silviculture under a suitable adaptive management framework where the desired future conditions are clearly identified, actions to meet those objectives are carefully planned and followed up by a review of the outcomes. Often, despite having chosen an appropriate silviculture regime, the timing of the treatment and the harvesting system selected failed to provide the right conditions to establish a new generation of trees.



DOCUMENTARY VIDEO

Sustainable management of our hardwood forests

We must keep implementing sound processes so that silviculture practices are sustainable, and our forests keep providing the products we need from them in the future. The design of a silviculture prescription system that provides the mechanisms to produce the desired short, medium, and long-term outcomes is crucial to sustain hardwood stands in our region.

Paired with a robust but simple adaptive management model so that adjustments can be made when variances are encountered, forest managers should be well equipped to assure that quality hardwood stands are plentiful in the future.

The NHRI has produced a documentary video explaining the challenges that exist with sustaining our hardwood resource. This documentary video will serve as an introduction to many more videos to come!

SPOTLIGHT ON OUR INTERNS
Caroline Bennemann

My name is **Caroline Bennemann** and I am one of the new interns at the NHRI and new PhD student in forest sciences at Université Laval. My four-year research project ''*Creation of value through the improvement of bucking techniques for cut-to length mechanized forest operations performed in deciduous-dominated stands*" began in September 2020. The overall aim is to improve bucking of hardwood trees through the use of harvester on-board computer data. Research will mainly be conducted in hardwood-dominated forests of New Brunswick.

This project is led by Eric R. Labelle, Professor of digital forest operations at Université Laval, Jean-Martin Lussier, research scientist in silviculture and forest production at the Canadian Wood Fibre Center in Québec, and directly supported by Gaetan Pelletier at the NHRI. The project is funded by a Mitacs Accelerate Fellowship with the NHRI as partner.

Prior to rethinking hardwood bucking, it is essential to obtain an overview on the state of mechanized harvesting in New Brunswick. Once this is done, the bucking process will be redesigned by including on-board computer data. Afterwards, a comprehensive field validation phase will occur. It is a major initiative that will likely be filled with challenges, while offering multiple learning opportunities.

Due to the actual sanitary situation, this project started under particular conditions. I remain somewhat stranded in Germany where I grew up and live at the moment. I am both French and German and studied forestry sciences at the Albert-Ludwigs-Universität in Freiburg (Germany), AgroParisTech Campus de Nancy (France) and at Technical University of Munich (TUM, Germany). I obtained my master's degree in September 2019 with special focus on mechanization of hardwood harvesting. Subsequently, I worked for almost a year as a research scientist in a research project aimed at assessing the performance of modified harvesting heads to allow the integration of debarking in the harvesting process.

I can't wait to finally come to Canada and continue my exciting PhD project there!

SPOTLIGHT ON OUR INTERNS
Mohammed Henneb

Mohammed Henneb, of Algerian origin holds a master's degree in biology (2014) and an environmental science PhD (forest sector, 2020) from the University of Quebec in Abitibi-Témiscamingue (UQAT).

He currently works on a postdoctoral research project aiming to develop modeling tools to predict commercial hardwood regeneration patterns in the New Brunswick Acadian forest. The project will produce targeted deliverables for the scientific community, forest companies and governmental agencies related to the forecasted impacts from environmental and silvicultural factors on commercial hardwood regeneration. These deliverables will include specific recommendations that forest companies and governmental agencies could implement to ensure sustainable silvicultural activities in hardwood and mixed-wood stands.

Supevision/coordination team

Mohammed's work will be supervised by Gaetan Pelletier from the NHRI and Marie-André Giroux from the Université de Moncton (K.-C.-Irving Research Chair in environmental sciences and sustainable development). Three valuable collaborators are involved in this project: Nelson Thiffault and Mathieu Fortin, scientific researchers at the Canadian Wood Fibre Centre from the Canadian forest service (Natural Resources Canada) and Chris Hennigar, forester at the Forest Strategy Section, at the N.B. Natural Resources and Energy Development.

The NHRI is pleased to announce that M. Henneb will join its team as a full-time researcher in early 2021!

His expertise:

- forest ecology
- forest management
- forest regeneration
- forest soil
- statistical analysis of ecological data.

SPOTLIGHT ON OUR INTERNS
Stéphanie Landry

Stéphanie Landry, intern at IRFN Inc. since July 2020, holds a bachelor's degree in biology from the Université de Moncton and a master's degree in environment from the Université de Sherbrooke. She is currently a Ph.D. candidate in biology at the Université du Québec à Rimouski (UQAR).

Being passionate about nature since a very young age, Stéphanie's project focuses on plant-wildlife interaction, more specifically on the influence of landscape structure on moose browsing intensity.

Since the beginning of the 20th century, the abundance of several ungulate species has increased more or less continuously and are now reaching very high densities in certain regions of the world, especially south of the St. Lawrence where the grey wolf has been exterminated. The moose population of New Brunswick is no exception, the northern part of New Brunswick has for the past several years been home of one of the highest population densities in North America.

The increase in herbivore pressure is not without consequences for the forest ecosystem. Intense browsing by moose has the potential to prevent saplings from growing into canopy trees. It can also change the species composition of forest stands, reduce stem density and diversity, decrease the growth in height of trees, and change their geometry. Therefore, moose browsing can decrease the economic value of a stand by reducing timber quality and production and by increasing rotation time, even when damage level is low.

In order to reduce negative impacts on the forest industry, it is important to understand the factors influencing the spatial patterns of moose browsing distribution. In this project, we will focus on the proximity and area of winter habitats, as well as forest and environmental factors.

This project is conducted under the codirection of the professors Martin-Hugues St-Laurent (UQAR) and Marc-André Villard (Université de Moncton/UQAR). The project is funded through a Mitacs Accelerate grant obtained through the collaboration of IRFN Inc.

SPOTLIGHT ON OUR INTERNS
Bastien Vandendaele

Bastien Vandendaele holds a bachelor's degree and a master's degree in bio-engineering from the University of Liège-Gembloux Agro-Bio Tech (ULG - Belgium) where he specialized in forest and natural areas management. He completed his master thesis at the University of Sherbrooke on the development of methods for the use of terrestrial lidar in forest inventories. Passionate about new digital technologies, he is currently completing a PhD thesis at the University of Sherbrooke in collaboration with the NHRI, ULG and FPInnovations on the use of UAV-based lidar data in precision forestry. During his thesis, Bastien had the opportunity to integrate the NSERC AWARE research project which aims to promote the use of remotely sensed data to enhance forest inventory and modelling of Canada's forest ecosystems. This experience allowed him to collaborate with universities, government agencies and forest industries across Canada. As a result, he benefits from a deep knowledge of the current issues and needs of the Canadian forest sector and is determined to contribute to its development.

Bastien's work at NHRI?

Bastien now integrates the Digital Timberlands 2020 project where he is responsible for the component on the exploitation of UAV-based lidar and mobile terrestrial lidar data to support wood harvesting operations. His work involves developing methods for extracting structural attributes at the scale of individual trees from high-density lidar point clouds. His involvement will provide a better understanding of the potential and limitations of these new mobile sensors in order to integrating the new generation of enhanced forest inventories.

This project is funded by a Mitacs Accelerate grant in partnership with the NHRI and the University of Sherbrooke. Bastien will be supervised by Gaetan Pelletier, NHRI executive director and Richard Fournier, Professor in the Department of Applied Geomatics at the University of Sherbrooke specialized in remote sensing of natural ecosystems.

SPOTLIGHT ON OUR INTERNS
Anis Zouagui

Anis Zouagui holds a diploma in forest engineering specializing in geoinformatics applied to natural resources in 2010 and a doctorate in water and soil conservation management in 2019. He is currently a master's student in forest science at the School of Forestry at the university de Moncton under the supervision of Lacina Coulibaly and Gaetan Pelletier. Anis has professional experience in applied research, specially, the application of geomatics technologies (GIS, remote sensing, spatial statistics) to soil and water conservation studies in watersheds.

Anis is currently a full-time employee at the NHRI.

Anis's work at NHRI?

Anis is part of the Precision Silviculture Team (ESP), his work is focused on developing a GIS-based model for predicting the production potential of tolerant hardwoods in New Brunswick. This tool will identify and classify sites based on their potential to produce high quality tolerant hardwoods. And subsequently, to support silvicultural methods that encourage the sustainable yield of the desired species and products. On the other hand, he participates in various projects of the institute by providing his expertise in the analysis of spatially referenced data and the integration of multi-source information into Decision Support Systems.

His expertise is on:

- Research in remote sensing and geomatics applied to forestry;
- Spatial and statistical analysis of spatial reference data;
- Production of detailed information on the forest by remote sensing, GIS, LiDAR
- Integration of multi-source information in decision support systems.

UPCOMING EVENTS

Due to the restrictions in place because of the pandemic, there are no trainings, or in-person workshops planned for the moment. However, we are very busy making content available electronically for our followers. The NHRI currently has many videos available and easy to access through our YouTube Channel on the following subjects:

- **NHRI:**
  - ⇒ Business Model
- **TOOLS:**
  - ⇒ Precision harvest treatment tool
  - ⇒ New Brunswick tree classification system
  - ⇒ Stand density management diagram
- **WORKSHOPS:**
  - ⇒ Tree bucking
  - ⇒ Towards hardwood sawlog yield increase
- **CONFERENCE:**
  - ⇒ 2019 CWF Fall meeting presentations
- **SPS:**
  - ⇒ Silviculture Prescription System (SPS)
  - ⇒ Trees from the same disturbance
  - ⇒ Over mature strata and patches of intolerant hardwoods and fir
  - ⇒ Shade tolerance
  - ⇒ Horizontal structure
  - ⇒ Base live crown
  - ⇒ Basal area
  - ⇒ AGS and UGS
  - ⇒ Acceptable regeneration
- **MISCELLANEOUS:**
  - ⇒ « Our forest at risk » (climate change)
  - ⇒ Collaboration — NHRI & IRSS (UBC)
  - ⇒ Operational trial of UAV-Based LIDAR scanning
  - ⇒ Optimizing the Hardwood Value Chain

SCAN ME

Follow us on Youtube

UPCOMING EVENTS

The NHRI also has online courses available via the UdeMy platform, for which you can register free of charge. The « Introduction to Hardwood Tree Bucking for Value » course is ready to go and we will post new ones as they become available.

⇒ **UdeMy (French Version)**

⇒ **UdeMy (English Version)**

THE LEAFLET

NHRI'S QUARTELY NEWSLETTER

NORTHERN HARDWOODS CONFERENCE 2022

"SMART ADAPTIVE SILVICULTURE IN CHALLENGING MIXED AND HARDWOOD STANDS"

Conference organized by:

UNB's Atlantic Forest Research Collaborative
Northern Hardwoods Research Institute

Fredericton, NB
2022

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